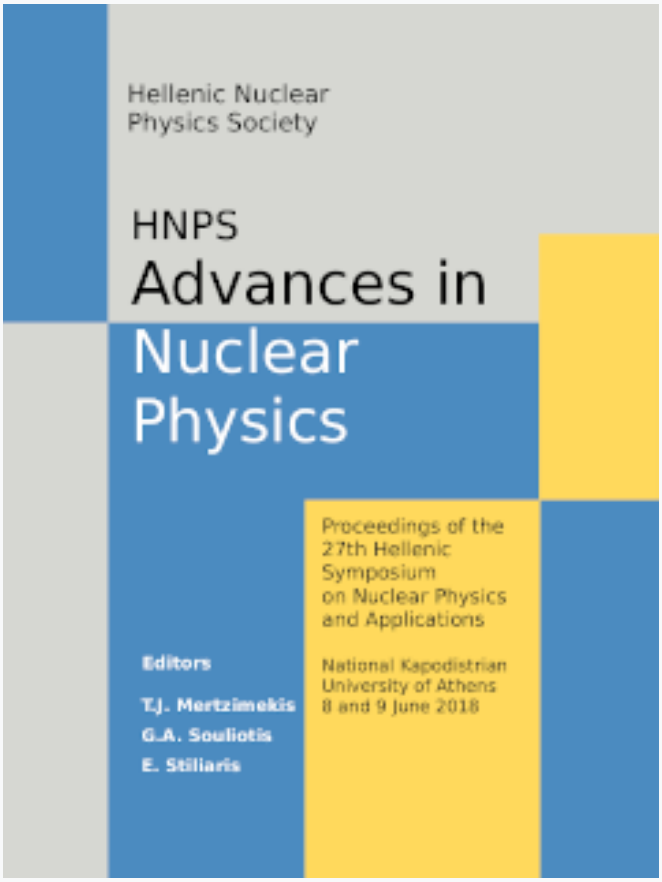
ePublishing

ΕΘΝΙΚΟ ΚΕΝΤΡΟ ΤΕΚΜΗΡΙΩΣΗΣ
EKT NATIONAL DOCUMENTATION CENTRE

HNPS Advances in Nuclear Physics

Vol 26 (2018)

HNPS2018



Variation of both tritium (3H) and beryllium (7Be) concentrations in air, rain and humidity samples collected at Ioannina, North-western Greece

K. C. Stamoulis, Z. Tsiligou, X. Aslanoglou, K. G. Ioannides

doi: 10.12681/hnps.1823

To cite this article:

Stamoulis, K. C., Tsiligou, Z., Aslanoglou, X., & Ioannides, K. G. (2019). Variation of both tritium (3H) and beryllium (7Be) concentrations in air, rain and humidity samples collected at Ioannina, North-western Greece. *HNPS Advances in Nuclear Physics*, *26*, 219–222. https://doi.org/10.12681/hnps.1823

https://epublishing.ekt.gr | **e-Publisher:** EKT | **Downloaded at:** 14/12/2025 07:39:56

Variation of both tritium (^{3}H) and beryllium (^{7}Be) concentrations in air, rain and humidity samples collected at Ioannina, North-western Greece

K.C. Stamoulis[1,2,*], Z. Tsiligou[1], X. Aslanoglou[1,2], K.G. Ioannides[1,2,3]

[1]*Department of Physics, University of Ioannina, 45110-Ioannina, Greece*
[2]*Archaeometry Center, University of Ioannina, 45110-Ioannina, Greece*
[3] *Current affiliation: Ret*

Abstract Studies concerning hydrological cycle, the movement of water through the atmosphere, surface and underground but also the ocean circulation, often use radioactive isotopes with short or long half lives to evaluate the time scales of these processes. The study of the temporal and spatial distribution of such radioactive isotopes help to understand the water movement. Usually these isotopes are produced in the upper atmosphere from the interaction of cosmic rays with nuclei of atmospheric gases. Among these isotopes, tritium (^{3}H) and beryllium (^{7}Be) are very important due to their comparatively short half lives, 12.33 y for ^{3}H and 53.12 d for ^{7}Be. Observed annual fluctuations of the production and consequently the transportation and precipitation of the isotopes on the earth surface, can be attributed to the climate conditions of the troposphere and stratosphere and to the seasonal changes of the boundaries between them.

In the present work results of a study of the variations of ^{3}H and ^{7}Be concentrations in air, liquefied air humidity and precipitation are presented. Tritium in precipitation and humidity were measured using liquid scintillation counting, while ^{7}Be in air and rain samples with gamma spectroscopy. An overall trend of decreasing concentrations of ^{7}Be during the winter months is observed showing a reversed behavior during the first spring months. Concentrations of ^{7}Be in rain samples were for the majority of the cases, below the limit of detection. Tritium concentrations in rain similarly to those measured in humidity, tend to increase during the winter months and decrease during spring.

Keywords Tritium, ^{7}Be, LSC, gamma spectroscopy

INTRODUCTION

Tritium (^{3}H) and beryllium (^{7}Be) are radioactive isotopes produced in the upper atmosphere from the interaction of cosmic rays with nuclei of atmospheric gases. Due to their comparatively short half lives, 12.33 y for ^{3}H and 53.12 d for ^{7}Be, they are used as tracers of the water cycling in the atmosphere, surface and underground waters and also atmospheric and ocean circulation. An annual fluctuation of the production and consequently the transfer and precipitation of the isotopes on the earth surface is observed which can be attributed to the climate conditions of the upper and lower parts of the atmosphere and also to the special seasonal changes of the boundaries between these two parts of the atmosphere, i.e. troposphere and stratosphere. Natural levels of ^{3}H concentrations in the atmospheric

* Corresponding author, email: kstamoul@uoi.gr

precipitation vary from 0.5 to 2 BqL^{-1}. The Tritium Laboratory of the Archaeometry Center of the University of Ioannina is among the few laboratories in Greece, which can perform tritium measurements in water samples [1,2,3,4]. A series of tritium concentration measurements in precipitation samples from the area of Ioannina, North-western Greece, are presented in Fig. 1. Beryllium-7 is measured in filters where an amount of air (usually 4-$6 \cdot 10^3$ m^3) passes through and the air particles, where ^7Be atoms are attached, are collected. Filters are placed into petri dishes and are measured by means of γ ray spectroscopy. In the present work the preliminary results of an ongoing study of the variation of both ^3H and ^7Be concentrations in air, rain and humidity samples collected at Ioannina, North-western Greece are presented.

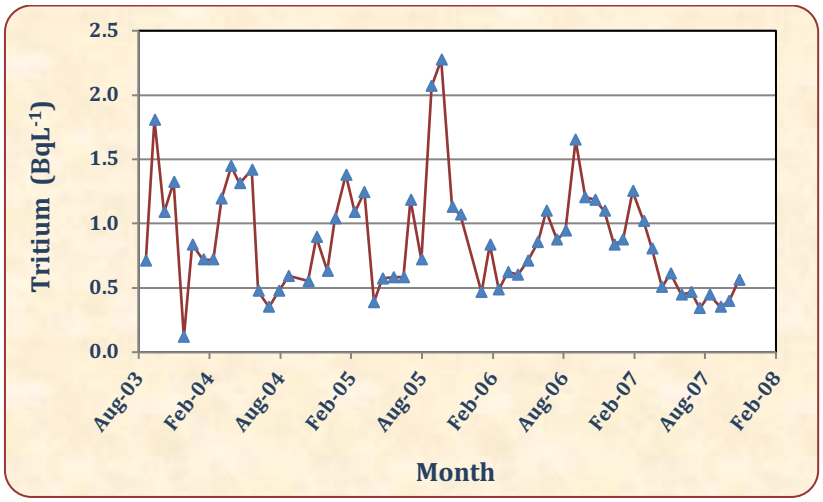


Figure 1. Tritium concentration in precipitation during 2003- 2008, at Ioannina.

MATERIALS AND METHODS

During a seven months period from (October–2017 to April-2018), 21 air samples were collected on glass-fiber filters (20x25 cm^2), for 3-4 days sampling time and with air flow of 1 m^3min^{-1}. Thirty six (36) rain samples were collected during storm events at the same period and were measured for tritium concentration as well for ^7Be. Finally 19 condensed humidity samples were collected during the same storm events to measure both ^3H and ^7Be concentrations. Tritium in rain and humidity samples was determined using liquid scintillation counting, while for ^7Be in air samples collected in filters and rain samples γ spectroscopy was utilized. All samples were measured for ^3H and ^7Be at the Archaeometry Center of the University of Ioannina. The Center is equipped with a super low-level background, liquid scintillation analyzer Tri-Carb 3170TR/SL (PerkinElmer, Inc), which is capable to measure very low concentrations of ^3H for applications in radiation protection and underground water measurements. Without any further processing, 8 mL of each sample were added in a low potassium glass vial of 20 mL capacity and mixed with 12 mL of Ultima Gold LLT scintillation cocktail, suitable for low level ^3H measurements. Each sample was measured for 1400 min. Rain and humidity samples were placed in plastic containers of 275 ml volume and were measured for ^7Be content with a HPGe broad energy detector with 1.9

keV FWHM at 1.33 ^{60}Co photo-peak and 26% relative efficiency. Air filters were measured for ^{7}Be content also in the same detector.

	Tritium		Beryllium-7		
Month	*Rain (BqL^{-1})*	*Humidity (BqL^{-1})*	*Air filters (mBqm^{-3})*	*Rain (BqL^{-1})*	*Rain Height (mm)*
Oct-2017	1.19 ± 0.04	1.06 ± 0.04	4.19 ± 1.58	-	20.5
Nov-2017	1.23 ± 0.33	1.16 ± 0.29	3.58 ± 1.19	0.81 ± 0.9	73.6
Dec-2017	1.31 ± 0.05	0.87 ± 0.03	1.7 ± 0.19	0.42 ± 0.38	104.6
Jan-2017	1.53 ± 0.54	1.3 ± 0.04	1.67 ± 1.22	0.48 ± 0.6	18.2
Feb-2017	1.47 ± 0.24	1.55 ± 0.46	0.6 ± 0.17	0.11 ± 0.28	66.6
Mar-2017	1.31 ± 0.65	0.94 ± 0.35	1.32 ± 0.52	0.55 ± 0.65	61.6
Apr-2017	2.46 ± 0.69	1.52 ± 0.05	2.95 ± 1.47	-	4.8

Table 1. Tritium and Beryllium monthly concentrations in rain and humidity during the period from October-2017 to April-2018, at Ioannina

RESULTS AND DISCUSSION

The results are presented in detail in Fig. 2 and 3 and monthly mean values with the associated uncertainty in Table 1. Beryllium concentrations in the air samples, show an overall trend of decreasing during the winter months while there is a small but obvious increase of the concentrations during the first spring months.

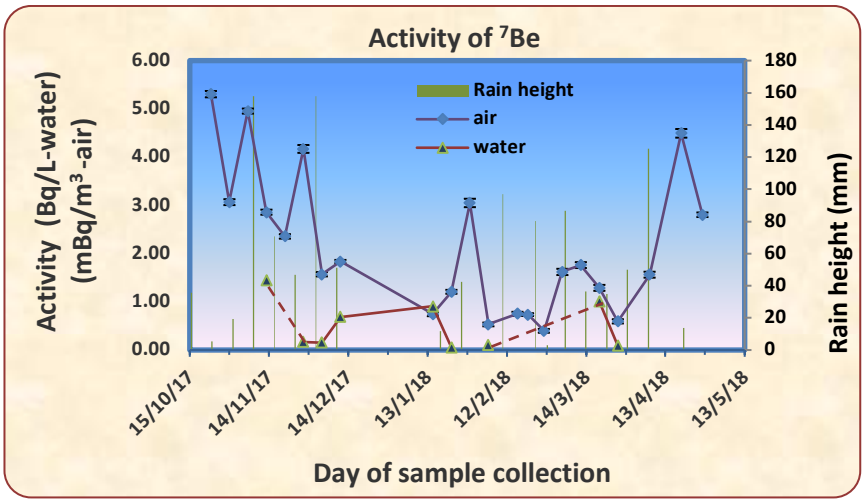


Figure 2 Beryllium-7 concentration in air and rain samples during the period from Oct-2017 to Apr-2018, at Ioannina. Weekly rain height (mm, second axis) is also reported

A similar trend was reported in another study in Thessaloniki, Northern Greece [5]. Concentrations of ^{7}Be in rain samples were in the majority of the cases, below the limit of detection. In some cases values were still low but measurable. Tritium concentrations in rain were similar to those measured in humidity samples and generally tend to increase during the whole period of the study. Similar results considering ^{3}H concentrations in rain have been

observed in previous studies [2, 3]. This variation in tritium concentrations is also observed in Fig. 1, where data from a 5-years period are presented. A weak correlation was found between the temporal evolution of ^{7}Be and ^{3}H concentrations. This may be confirmed when more results will be obtained. Tritium monthly mean concentrations in rain water varied from 1.2 - 2.5 BqL^{-1} showing an average value of 1.5 ± 0.5 BqL^{-1}, while monthly averages of humidity samples varied from 0.9 - 1.5 BqL^{-1} with an average of 1.2 ± 0.4 BqL^{-1}. Individual ^{3}H monthly concentration means with the associated uncertainties (± 1sd) are presented in Table 1. Beryllium monthly concentration means in the air were found to vary from 0.6-4.2 mBqm^{-3}, with an average value of 2.2 ± 1.5 mBqm^{-3} while in the rain the values were very low varying from 0.1 - 0.8 BqL^{-1}. Also individual ^{7}Be monthly concentration means with the associated uncertainties (± 1sd) in air filters and rain are presented in Table 1. Meteorological data for the rain height (mm) are presented graphically in Fig. 2 and 3 (weekly values) and in Table 1 (monthly total). It is noticeable that ^{7}Be concentrations in the air tend to decrease significantly after a strong storm event while tend to increase during periods of drought.

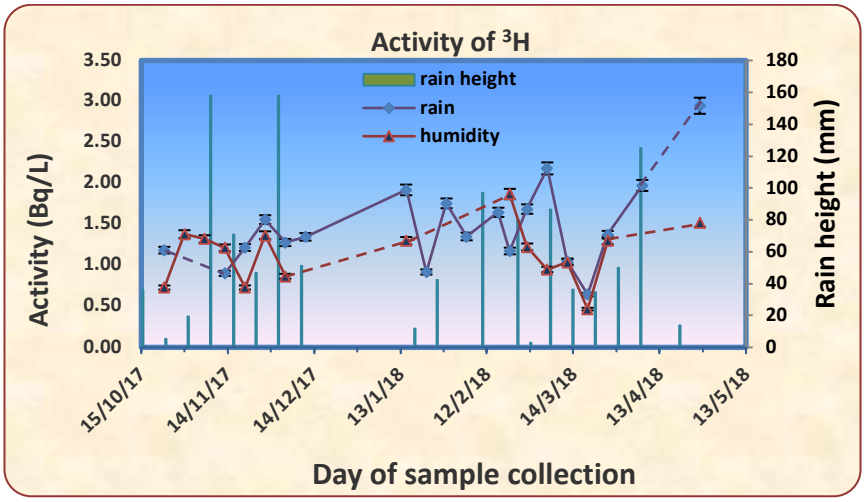


Figure 3 Tritium concentration in rain and humidity during the period from Oct-2017 to Apr-2018, at Ioannina. Weekly rain height (mm, second axis) is also reported

References

[1] K. Stamoulis et al., Fusion Engineering and Design 86, 206-213 (2011)
[2] K. Stamoulis et al., Fusion Science and Technology 48(1), 512-515 (2005)
[3] K.C. Stamoulis, K.G. Ioannides, Proceedings of CEST2009, B 901-907, (2009)
[4] https://sites.google.com/site/archaeometrycenter/tritium-laboratory
[5] A. Ioannidou et al., J. Radioanal. Nucl. Chem. 289, 395-400 (2012)